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Interlinkages And Volatility Transmission Between The Stock Market Of Developed Countries And India

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Abstract

Purpose:Global Financial liberalizationhas increased the integration of the stock market worldwide. The conditional volatility of the financial market is an important factor responsible for the stock market return and reaping the benefits of diversification for investors. The purpose of the paper is to estimates the interdependence of volatility of stock indices of countries like India, China, USA, and Japan.

Design/ Methodology:GARCH model has been used to find the co-movement and volatility transmission among the stock markets. Daily closing prices of NIFTY (India), SENSEX (India), NIKKEI (Japan), NASDAQ (U.S.) and, SHANGHAI (China) over the period from January 2008 to December 2019S has beenusedinthestudy.

Findings: The result indicates that ARCH and GARCH effect is significant among Nifty, SENSEX and NASDAQ but not significant for SHANGHAI and NIKKEI stock indices.

Research Implication:The volatility interactions between Nifty and NASDAQ are more prominent as compared to other stock indices considered. The US market act as an leading indicator for the Indian stock market.

Practical Implication: The research can aid the investors in forming a diversification strategy. The co-movement of stock indices can aid in developing an optimum portfolio that maximizes return and reduces risk. The policymakers can also benefit from the study in establishing a lead-lag relationship of the transmission among stock indices.Investors and researcher also have a keen interest to study the interdependence of the financial market are suggested to study the movements of NASDAQ before making investment decision for Nifty.

Originality / Value: The study adds to the body of literatureby exploring the financial integration among various indices. The research also discusses lead-lag relationship of selected stock market specifically post subprime crises.

Keywords: Financial Integration, Volatility, GARCH/ARCH, developed economy, time series, emerging economies. Stock market.

Introduction

Globalization has increased the Financial Integration and dependency of economies. Today

world economy is characterized by free mobility of capital, integration of financial service and financial openness. Subprime crisis and devaluation of Chinese currency have revived the interest and concern of policy makers in the global financial correlation of the markets. Financial Interdependence brings the benefits of efficient capital allocation but is accompanied by volatilitytransmission. Thevolatility of one stock market not only affects the risk and returns but also increases the variability of other stock markets. Information spill over increases the dependence of one international market to another. Consequently, one stock market may act as leading indicator for another. With this back ground the paper attempts to study the volatility transmission from developed countries to India

The study is extremely critical for the investors and policy makers. Global integration smoothensinter-temporal consumption, internationaltrade and portfolio diversification opportunity. However, it is accompanied with withdrawal of investment at the time of crisis(Forbes & Rigobon, 2002).To establish a lead lag relationship; the investigation of the transmission mechanism is essential fromthe policy makers. Investors and researcher also have a keen interest to study the interdependence of the financial market. An investor uses diversification strategy by investing in foreign financial markets and in domestic markets. To obtain an optimum portfolio that maximises return and reduces risk, the investors explore the correlation of volatility among various stock markets. Highly integrated stock market indicates that the investor cannot benefit through diversification strategy as the returns of the indexes are correlated. (Ling & Dhesi).

This research contributes to the existing body of literature by studying the concept of financial integration for emerging country like India. India is one the attractive markets for investing capital. Economicreforms of 1991 have led the country towards capital account convertibility. As a result; volatility transmission from the developed capital market to Indian stock exchange becomes an important area of research. The study investigates the integration of the Indian stock market with major stock market of the worldnamely USA, Japan, and China. These three-stock markets occupylead the international capital market based on market capitalization and India is a growing stock market.

Based on the literature review, the financial integration of the stock markets has documented mixed results. Some researchers have documented that the volatility transmission is from developed markets to developing countries, while others have contradicted the findings. Unification of the global market is a well-accepted concept. However, most of the previous research focuses on developed economies. With limited research on emerging economies, India represents an important case of study. Despite variousstudies on estimating the stock market volatility, no research discusses the interdependence of selected stock markets post subprime crises. Thus, the research is an attempt to fill this gap.

The study uses daily closing prices of NIFTY (India), SENSEX (India), NIKKEI (Japan), NASDAQ (U.S.), SHANGHAI (China) over the period from January 2008 to December 2019.Volatility analysis of the Indian stock market with the other stock markets are explored usingGARCH model. The remainder of the paper has the following structures; section 2 reviews the relevant literature on volatility transmission among stock market. Section 3 discusses the methodology which has been used to study financial integration .Section 4 documents the result of the research followed by conclusion.

2. Literature Review

In order to build the conceptual framework and a base for further research, a review of existing literature is done. There have been a vast body of literature exploring the volatility clustering in stock exchanges. However, volatility of one stock market may affect the risk and returns of other

stock markets. Some of the important literature modelling the interrelationship volatility among the stock exchanges of USA, Japan, China and India are discussed in this paper.

For estimating volatility different statistical tools have been used by different researchers across the globe. (Mandelbrot, 1963) and (Fama, 1965) explained various factors affecting stock returns which are important in modelling stock market volatility and they found volatility is time varying and exhibits positive volatility clustering. (Nathani, Kaur, & Shrivas, 2015) point that Stock market volatility affects currency movement and vice versa (T. Bollerslev, Chou, & Kroner, 1992) explained that the volatility of returns can be characterized as a long-memory process as it tends to persist. The results were supported by researchers(Schwert, 1989)and (Fama, 1965). (Engle, 1982) documented that time series are found to autoregressive, depending on past information (conditional) and demonstrate non-constant variance (heteroskedasticity).The researcher introduced the Autoregressive Conditional Heteroskedasticity (ARCH) model to model financial time series data that exhibit heteroskedasticity. (Bollerslev, 1986)explained Generalized ARCH (GARCH)model by extending it for estimating stochastic volatility. (Akgiray, 1989) found that GARCH (1,1) had better explanatory power to predict future volatility in stock market. (Poshakwale & Murinde, 2001)modelled volatility in stock markets of Hungary and Poland using daily indexes and found that GARCH (1,1) accounted for nonlinearity and volatility clustering. (Poon & Granger, 2003)provided comprehensive review on volatility forecasting and found that Arch and GARCH classes of time series models are very useful in measuring and forecasting volatility. The volatility will be estimated with the help of GARCH model.

In the Indian context (Karmakar, 2007) found a positive but statistically insignificant relation between the conditional variance and the expected returns. (Padhi, 2006)investigated time varying risk-return trade-off in the Indian stock market and found mixed results with majority of the cases revealing a positive risk-return relationship with significant statistical support. (Shin, 2005) studied the stock return and volatility and explained that evidence on asymmetric effect in stock market volatility is still paradoxical in nature and hence calls for a thorough revisit. (Aggarwal, Inclan , & Leal, 1999) examined the events associated with the sudden shift in volatility of stock market returns and found that mostly country specific events caused big shift in volatility rather than global events or change in exchange rate regimes. (M. T. Raju & Ghosh, April 2004,) have compared 18 countries by dividing them into developing and developed economies and found that the returns of markets in India and China whereas high as that of United States (US) and United Kingdom (UK) but the volatility of both the markets was higher. (Sarkar, Chakrabarti, & Sen, 2009)analysed transmission of volatility across countries leading to volatility while Kang and Yoon(2012) identified global events responsible for increasing volatility in most of the Asian markets. (Banumathy & Azhagaiah, 2015) modelled the stock market volatility S & P Nifty from 2003 to 2012 using both symmetric and asymmetric model of GARCH. The study did not find any significant relation between risk and return. However, the negative shocks have pronounced impact on the volatility of the stock market as compared to positive shocks.

There are various studies on interdependence among equity markets focused on the interdependence among developed and emerging markets, US being the most influential. (Cha B. a.-L., 1998) examined found strong evidence of co-movements amongUS and Japanese market on Asia's market where US market is leading other markets. (MacDonald, 2001) studied the interlink ages among Central and Eastern Europe and found significant long run co-movements among them. (Chen, Lobo, & Wong, 2006) examined long term linkage between India, US, and China and found the linkage between Indian and Chinese stock market was strong during the period of study as compared to US market. (BharBiljana & Nikolova, 2007)studied degree of integration of the BRIC countries and global

basis and observed high degree of integration exists between the BRIC countries and their respective regions and lesser with rest of the world.

(Kim,2010) studied the impact of shock on US stock market to East Asian Economies namely Hong Kong, Singapore, Korea and Taiwan. He found that there is a unidirectional causal relationship between US stock market and East Asian economies running from US to East Asian economies. (Singh, 2010) analysed the linkage between China and India with major developed markets and concluded that both stock market is co integrated with all the four developed markets and also there exists a bilateral causality between India and China. (Tripathi & Sethi, 2012) examined the interlink ages between India and other emerging economies by using Granger Causality and he found that short term linkage of Indian stock market with the advanced emerging economies has increased over the period of study. Based on the literature review the study attempts to study if developed global market act as a leading indicator for stock market in India

3. Research Methodology

The research paperuses GARCH model to study the interlink ages of developed and emerging stock indices of different countries. The sample includes four economies namely India, Japan, China and US. The study followed the IFC classification for selecting the emerging stock market. The stock markets' indices used in the study are SENSEX, Nifty, NIKKE, Shanghai Composite, and NASDAQ. The study is based on the secondary data that were collected from reliable websites like Index mundy, trading economies and World Bank, Centre for Monitoring Indian Economy (CMIE). The data consists of daily closing prices of NIFTY (India), SENSEX (India), NIKKEI (Japan) ,NASDAQ (U.S.) , SHANGHAI (China) over the period from January 2008 to December 2019. Stock returns have been calculated on the daily basisof all the selected indices to conduct analysis. In parallel with Yu (2002), return (r) is defined as natural logarithm of first difference of daily closing price, which is as follows:

Rt= Log (pt/pt-1)where Rt is the logarithmic daily return on Nifty index for time t, Pt is the closing price at time t, and Pt−1 is the corresponding price in the period at time t − 1.

Development of ARCH and GARCH (1,1) model

Mean Model

Mean model is NSE = c (1) +c (2) +BSE+NIKKI+NAS+SHANG

Where, ……..(1)

NSE = Dependent variable

c (1) = Constant

c (2) = Coefficient

Independent variance = BSE, NIKKI, NAS, SHANG

Variance equation

Variance equation is h_t=c (3) +c (4)*h_t-1+c (5)*e^2t-1

Where,

h_t= NSE volatility

c(3) = constant

h_t-1 = previous day's residual (lag of h_t) of NSE – (GARCH term)

h_t = current period volatility and h_t-1 is previous period volatility

Tools Used For Data Analysis

Descriptive Statistics: To specify the distributional properties of the daily return series of all the stock indices during the study period, the descriptive statistics are reported in table 1. It shows mean (X), standard deviation (σ), skewness(S), kurtosis (K),Jarque-Bera statistics etc.

Test for Stationarity: First of all, there is a need for testing whether the data are stationary or non-stationary and it is found out by unit root test, which is conducted by Augmented Dickey-Fuller Test (ADF) (Dickey and Fuller 1979).

4. Result and Analysis

To specify the distributional properties of the daily return series of stock market indices during the study period, descriptive statistics have been reported in table 1. The highest mean annualized log returns are of, 49.26802 and the lowest are of BSE 3.617742. As expected, volatility is very high in emerging markets; and NIKKEI have the highest levels of volatility (as measured by standard deviation) in log returns, at 3.185011 and 3.331893. NSE and SHANGHAI are the least volatile emerging markets during the study period, with standard deviation of 1.813734 and 2.965224 respectively. Skewness, which represents the nature of departure from normality is clearly observed for the returns of all the stock indices. The kurtosis figures reflect that the distribution in all the stock indices is peaked (leptokurtic) relative to kurtosis 3.Likewise, the Jarque-Bera (J-B) statistic, which is a test for normality, also confirms that the null hypothesis of normality for the daily log returns of all the stock indices should be rejected at the 1% significant level.

In a normal distribution, skewness is 0 and kurtosis should be near to 3. In case of NSE, BSE and NASDAQ, the data is fairly symmetrical as it is lying between -0.5 to 0.5 but for all the other indices, the data is highly skewed which implies that distribution is deviated from normality. The result of kurtosis represents that due to high value (more than 3) all the time series are heavy tailed than a normal distribution. It is consistent with the outcomes of JB test that the data is not normally distributed as the p values for all the indices are zero. Null hypotheses that the data is normally distributed are rejected. Consequently, pre mentioned analysis gives the support and suitability to apply ARCH and GARCH model in the gathered data.

Table 1 To be Inserted

Since the study used time series data, hence stationary of data series becomes important for drawing meaningful implications. It enhances the accuracy and reliability of the data, reason being that if the variable is not stationary; it can lead to unauthentic relationship in the analysis. Table 2 shows the presence of unit root in the series tested using Augmented Dickey-Fuller Test (ADF) (Dickey and Fuller 1979). The p values of

Augmented Dickey-Fuller Test are less than 0.05, which lead to conclude that the data of the time series for the entire study period is stationary. The ADF test statistics reported in table 2 reject the hypothesis at 1%level. Hence, the results of the test confirm that the series are stationary and also authenticate absence of autocorrelation.

Table2tobeinserted

The main objective of this research was to study the influence of volatility of the stock indices of BSE SENSEX, NIKKEI, NASDAQ, and Shanghaistock market on the volatility of the stock index, NIFTY of NSE. After building the ARMA model for estimating mean, volatility has been modelled through ARCH and GARCH. GARCH model is one of the important models in capturing the persistence of volatility observed in time series. For all the series studied, descriptive statistics were obtained including a test for auto correlation to know the possibility of ARCH. Based on statistics, it was decided to use GARCH (1, 1) model.

Figure 1 to be inserted

ML - ARCH (Marquardt) - Normal distribution

First of all, GARCH (1, 1) with normal Gaussian method has been applied, which resulted into the following equation (refer Annexure, table 3.1):

GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1) + C(6)*NIKKI + C(7)*NAS + C(8)*SANG + C(9)*,

is suitable for model selection. The model with high r square value and min AIC is selected. The results are similar to that of (Cha & Cheung, ,

Figure 2 to be inserted

ML - ARCH (Marquardt) - Student's t distribution

Student's t distribution is a one of the alternative of GARCH (1, 1). Student's t distribution Gaussian method has been applied which resulted into the following equation (refer Annexure, table 3.2):

GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1) + C(6)*NIKKI + C(7)*NAS + C(8)*SANG + C(9)*,

For driving mean equation, least square has been applied and the results indicated that there is no relationship between returns of BSE and NSE. In other words the returns of NSE are not affected by BSE.

The equation revealed that the ARCH term and GARCH term are significant with coefficient value of RESID (-1)^2(0.262425) and GARCH(-1) (0.608466), significant at 0% respectively hence it can be concluded that the internal shocks are affecting NSE index. The other coefficient values of NIKKI (-0.029985), SANG (-0.035840),(-0.008212) are not significant and not affecting NSE index except NAS (-0.327679) which is significant at 5% level. The model further predicted the high value of likelihood and minimum value of (AIC) Akaike info criterion, which

1998) who conducted a similar study on US, Japan and some Asian markets. The results are also supported by (Kim, 2010) who tried to investigate USandEastAsiannations.

The equation revealed that the ARCH term and GARCH term were significant with coefficient value of RESID(-1)^2(0.137744) and GARCH(-1) (0.840961) significant at 0% respectively. Henceit is concluded that the internal shocks are affecting NSE index. The other coefficient values of NIKKEI(-0.004444),SANG(-0.005879),(-0.006283) are not significant and not affecting the NSE index, except NAS(-0.063625) which is significant at 5% level.

Figure 3 to be inserted here

ML - ARCH (Marquardt) - Generalized error distribution (GED)

Generalized error distribution (GED) is one of the alternative methods of GARCH (1,1). Generalized error distribution (GED) Gaussian method has been applied which resulted into the following equation (refer Annexure, table 3.3):

GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1) + C(6)*NIKKI + C(7)*NAS + C(8)*SANG + C(9)*

The equation revealed that the ARCH term and GARCH term are significant with coefficient value of RESID (-1)^2(0.306063) and GARCH(-1) (0.602265) significant at 0% respectively. Hence, it is concluded that the internal shocks are affecting NSE index. The other coefficient

values of NIKKEI (0.029225), SHANGHAI (-0.030015), (-0.007675) are not significant and not affecting the NSE index, except NASDAQ (-0.374804) which is significant at 5% level. Both daily returns and standard deviation are higher for emerging markets over developed and developing markets. This finding of the research

collaborates with earlier finding of is in conformity with the observations made by (Bekaert & Harvey). However, the findings are not supported by the studies of (Singh, 2010) and (Chen, Lobo, & Wong, 2006) who found very fractional linkage between India and US.

Figure 4 to be inserted

Figure 1, 2, 3 and 4 depict prolonged period of low volatility from day 1 to day 250 and also there exist a period of high volatility from day 1000 till 1250. In other words, period of high volatility is followed by period of high volatility and the period of low volatility tends to be

followed by period of low volatility. This suggests that residual or error term is conditionally heteroscedastic and it can be presented by ARCH and GARCH model. Themodel reveals that the Indian stock market is integrated with the markets of US, Japan and China. However, the co-movement is stronger with NASDAQ. The integration of US and Indian market may be due to strong financial ties between the two markets and the time lag between the markettiming.

Conclusion

In this paper volatility estimation and transmission between stock markets indices of U.S, Japan, and China have been studied using GARCH model. Daily returns of the stock market of the developed countries have been regressed with the emerging stock market index of India to find out the lead and lag relationship. The shift in volatility of indices returns of emerging stock markets and their impact on the volatility of the Indian stock exchange was studied during the period 2008-2019. The empirical results documented that developed and developing emerging markets show distinct pattern in return and volatility behaviour. Both developing markets and developed markets have recorded extreme values in returns and standard deviation during financial meltdown. Second, asymmetry pattern as shown by skewness and kurtosis have

been different for developed and developing emerging markets. The study further reveals that ARCH and GARCH effect are not significant in SHANGHAI and NIKKEI stock indices while significant among NIFTY, SENSEX and NASDAQ.

The study concludes that volatility in the US stock market greatly influences the returns and risk of NSE, India. The study limits itself in scope. It only studies the co-movement of three stock markets. Future research can study other stock markets to study financial integration. Despite the limitation of the study, investors can use the findings of the research. Both institutional and retail should consider the NASDAQ movement before investing in the National Stock Exchange, India. The policymakers should study the US market while forming risk management for the stock market.

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Table 1 Descriptive Statistics

	NSE	BSE	NIKKEI	SHANG	NAS
Mean	4.187950	3.617742	2.189939	12.74899	3.703575
Median	4.254376	3.562655	2.167292	12.67491	3.750613
Maximum	21.82692	15.94031	122.0700	46.13202	15.46738

Minimum	-8.154881	-11.14136	-7.072385	-3.718753	-5.480962
Std. Dev.	1.813734	1.675508	3.185011	2.965224	1.476601
Skewness	-0.013371	0.050266	29.64217	1.998649	0.074591
Kurtosis	11.80489	10.08009	1116.694	24.60677	10.03301
Jarque-Bera	5814.511	3760.332	93287172	36212.33	3711.413
Sum Sq. Dev.	5918.046	5050.384	18249.59	15817.80	3922.448
Observations	1800	1800	1800	1800	1800

Source : Authors calculation using Reviews

Table 2 : Stationarity Test

Null Hypothesis	**P value**	**Null Hypothesis**	**Result**
NSE	0.0000	Rejected	Variable is stationary
BSE	0.0000	Rejected	Variable is stationary
NIKKI	0.0000	Rejected	Variable is stationary
SHANG	0.0000	Rejected	Variable is stationary

Source :Authors calculation using Eview

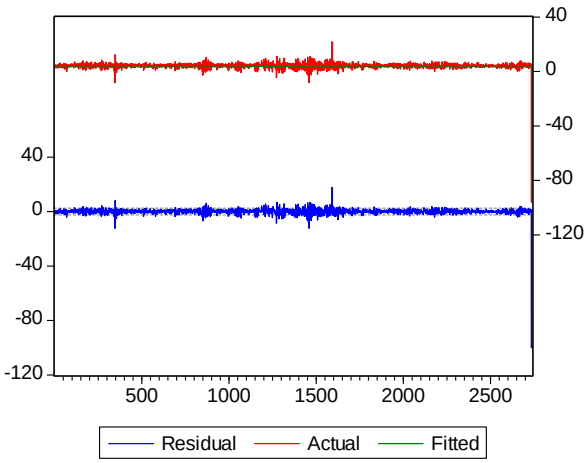

Figure 1: Residual

Figure 2: Residual

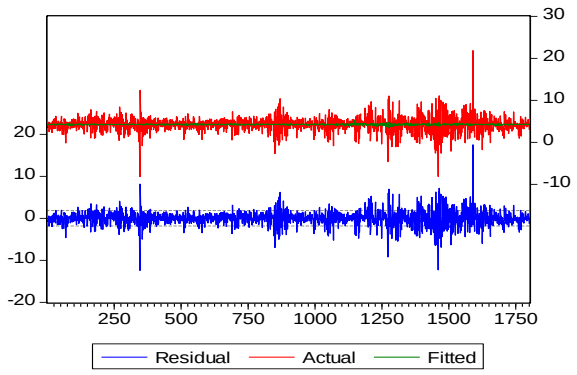

Figure 3: Residual

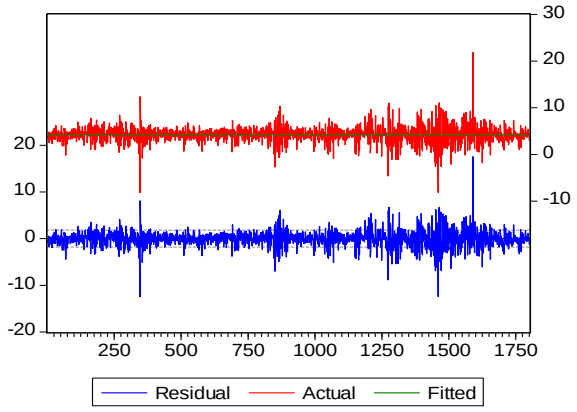

Figure 4: Residual